

short and heavy with a well developed deltoid ridge, reaching well below the middle of the shaft. A small portion of the shaft is missing and as here restored is probably somewhat too long. This element is not at all cetaceanlike in character. The bones of the forearm are flattened laterally and articulate with each other as they do in the whales and sea lions, resembling somewhat more nearly those of the latter. The manus is not known, but judging from modifications of the radius and ulna, it was evidently highly specialized and paddle or flipper like as in the whales and sea lions. The form and arrangement of these distal elements as here restored (see fig. 1) are necessarily in great degree conjectural, the corresponding parts in both the whale and the sea lion being used as a guide in modeling them. The fact that the known forefoot elements of the closely related genus *Dourdon*, a few phalanges of which are preserved with one of the specimens (No. 4679) in the United States National Museum, resemble so much more those of the sea lions than they do those of the whales, seems to justify including more sea lion than whale like characters in restoring the paddles. Thus digit I, the hallux, is shortened, and digits II and III are made longest and heaviest of the series.

The vestigial pelvic bones and femur, all that is known of the hind limbs, have been fully described by Lucas<sup>1</sup> and are mentioned and again figured here (see figs. 2 and 3, p. 652) because of the doubt which

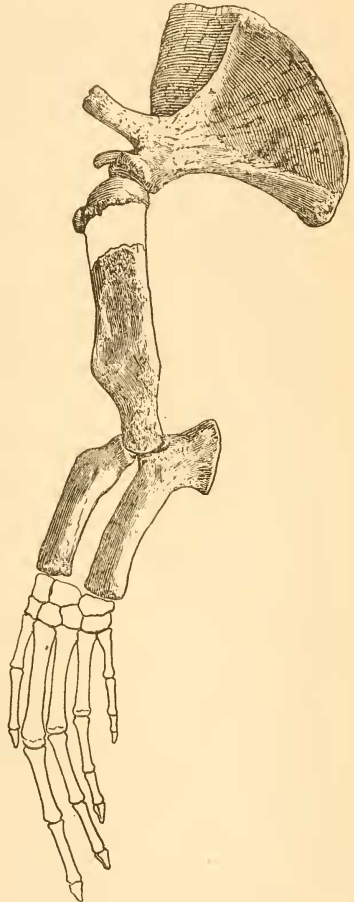


FIG. 1.—FORE LIMB OF AMERICAN ZEUGLODON.  
ABOUT  $\frac{1}{2}$  NATURAL SIZE.

<sup>1</sup> Proc. U. S. Nat. Mus., vol. 23, 1900, p. 329, pls. 5-7.

has been created as to their proper association with the skeleton to which they were supposed to belong. Abel, in an article published in 1906,<sup>1</sup> contended that these bones were the coracoids of a large bird to which he gave the name *Alabamornis gigantea*. A careful restudy of

these elements, however, leaves no doubt as to their mammalian characteristics and no reason to assume that they do not properly belong to the skeleton with which they were found associated. While they evince an extremely atrophied state, the acetabulum plainly retains traces of the cotyloid notch and the pit for the attachment of the ligamentum teres (see fig. 2, p. 652), while the bone is considerably thickened in this region. Also, the proximal end of the femur (see fig. 3, p. 652) shows evidence of having been capped with an epiphysis. Not having the actual bones to examine Abel doubtless was led to a wrong interpretation of the plates published by Lucas, because they do not show very clearly the essential characters of the bones. This is due to the fact that the bone surfaces are pitted and roughened through imperfect preservation and the reproductions, which are from photographs, are perhaps somewhat confusing.

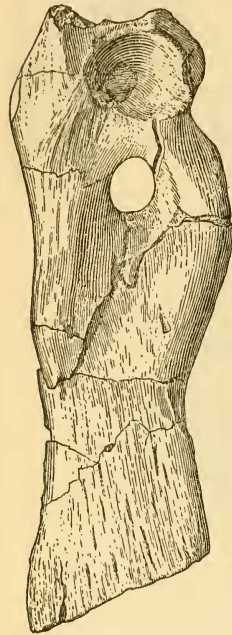


FIG. 2.—PELVIC BONE OF AMERICAN ZEUGLONON.  $\frac{1}{2}$  NATURAL SIZE.

The anterior portion of the vertebral column, including the cervicals and first seven thoracics, are not highly specialized and are typically mammalian in character. But from this point backward to the first lumbar, the vertebræ rapidly gaining in size and increased length of their centra, show a degree of specialization that is unique. The vertebræ from the beginning of the lumbar region to about the ninth from the end of the tail have exceedingly long, heavy centra and relatively small neural arches, and are comparatively uniform in size and general appear-

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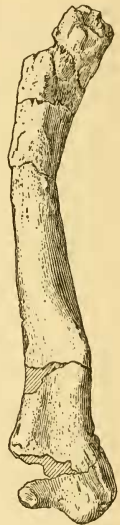


FIG. 3.—FEMUR OF AMERICAN ZEUGLONON.  $\frac{1}{2}$  NATURAL SIZE.

<sup>1</sup> Centralbl. Min. Geol. Paleont., p. 456.

ance throughout. Here the length of centra average about 15 inches, as compared with about 4 inches for the first thoracic. This gives to the skeleton a very remarkable appearance, viewed as a whole. It may be said to resemble that of a whale with an exceedingly small head, comparatively small thorax, and very greatly lengthened lumbar and caudal regions. The zygapophyses do not articulate with those of the neighboring vertebræ, except in the cervical and anterior thoracic vertebræ, and from the eighth thoracic backward to where they disappear near the end of the tail, are separated by intervals of about 5 to 7 inches, the anterior pairs being modified, apparently, for the attachment of the heavy back muscles, while the neural spines are correspondingly reduced. Thus for the greater part of the length of the vertebral column the vertebræ articulated only by their centra which are nearly circular at the ends and were probably capped by intervertebral cartilage disks of some thickness. This constitutes an arrangement which must have given to the long, slender body a perfectly free motion in almost any direction and doubtless rendered this great creature capable of diving and turning at will, or of swimming forward at tremendous speed. The short, stout, flexible neck, which doubtless was heavily muscled, also denotes agility in turning. In fact, the whole mechanical construction of the animal seems to denote that he was a most powerful swimmer, his entire development being especially adapted to rapid locomotion. If, as is indicated by the dentition, which seems admirably fitted for seizing and holding his prey, he fed on large swiftly swimming fishes, or other sea-living creatures, his very existence probably depended on speed.

It may be of interest here to recall the grotesque restoration by Koch which he constructed from zeuglodon bones and which several years ago was exhibited in various museums of this country. This restoration, which Koch called the *Hydrarchos*, was made up of the bones of many individuals, in which were included far too great a number of vertebræ and ribs, giving not only too great a relative length to the neck and thoracic region, but a very much exaggerated length to the whole creature. The history of this restoration is given concisely in a letter written by I. A. Latham to Prof. J. D. Dana in 1895, an extract from which is here quoted:

I have your kind letter of the 27th asking about the *Zeuglodon* skeleton, lost in the great "Chicago fire." It had been brought from St. Louis some years before, and was the same discovered by Dr. Albert Koch on the plantation of Colonel Price, situated near the line of Choctaw and Washington Counties, Alabama. It was removed to Dresden in Saxony, where after eight months labor, it was reduced in length from 114 to 96 feet. It was afterwards brought back to this country and purchased by the proprietor of a museum at St. Louis, from Doctor Koch. At Chicago it was one of the chief attractions of "Wood's Museum."

Although much has been written of the zeuglodons by various investigators who have compared in detail its various anatomical features and discussed at length its relationships, there still exists wide difference of opinion among authorities regarding the true affinities of the group. One point of weakness in all these discussions is the absence of any known intermediary forms to connect them with any of the other groups to which they may seem allied.

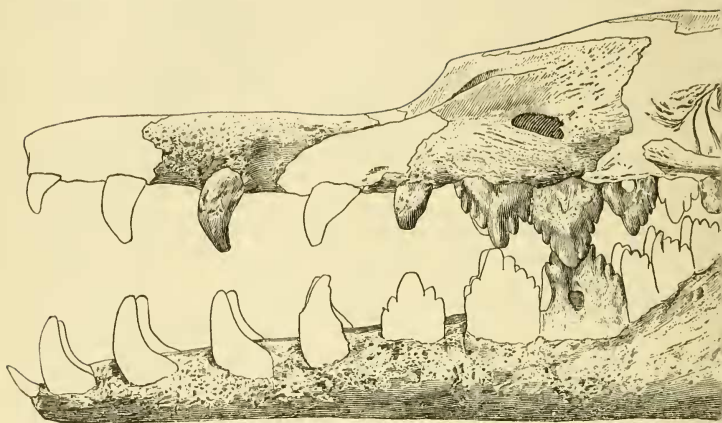
As has been pointed out by various authors,<sup>1</sup> the zeuglodons possess many primitive characters, especially in the skull and teeth, in which they resemble either the seals or the more ancient creodonts. In other characters, the ones in which they are more highly specialized, they resemble the whales in some respects; while in others, as in the modification of the arm, they suggest the sea lions. There is nothing, however, to warrant placing them in any intermediate position between these at present widely separated groups of mammals, for at the time of their apparent extinction in the Eocene they had already outstripped in the development of certain important modifications what has been accomplished by any of the modern cetaceans, hence could not have stood in any direct ancestral relationship to the latter, while the primitive features which they retained are too generalized in character to especially connect them with any of the more archaic groups of mammals. Furthermore, there is at present too much obscurity concerning the origin of the whales to arrive at anything definite regarding the derivation of the zeuglodons from any ancestral form of that group.

The high degree of specialization which they had attained in the development of the body and limbs, combined with the retention of so many primitive characters, would indicate a very ancient origin for these animals, and if derived from the same stock as the seals or sea lions or direct from the early creodonts, their branching-off point must have dated back to a time most remote, certainly before the various natural groups of the creodonts appearing in the early Eocene were sufficiently differentiated to be recognized.

<sup>1</sup> See Thompson, On the Systematic position of Zeuglodon, Univ. Dundee, June, 1890; Dames, Paleont. Abhandl., 1894, pp. 189-219; Zittel, Grundzüge der Paleont.; and others.



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SKULL AND CERVICAL VERTEBRÆ OF AN

FOR DESCRIPTION